

Pratyush Pranav

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Born: Feb 18, 1985—Darbhanga, India

Nationality: Indian

Areas of specialization

Cosmology, applied geometry and topology, topological data analysis, statistics

Research experience

- (Nov. 2017 -) ERC advanced grant postdoctoral fellow, ENS de Lyon, Univ. Lyon 1, Lyon, France.
(Focus: Development and interpretation of geometric and topological tools in the context of cosmological data sets. Topology and geometry analyses of CMB (Planck) and galaxy survey (SDSS) datasets.)
- (Nov. 2015 - Oct. 2017) ERC advanced grant postdoctoral fellow, Faculty of electrical Engineering, Technion, Israel.
(Focus: Topology and geometry of stochastic processes in general, and Gaussian and Gaussian-related random fields in particular. Investigating the topology of the temperature fluctuations in the CMB to test the hypothesis of isotropy, homogeneity and Gaussianity.)

Education

- 2010 – 2015 • PhD in Applied topology and Cosmology, University of Groningen, Groningen, The Netherlands.
(Focus: Geometry and Topology, Astrophysics (cosmology), and their interface. Development and application of tools arising from computational geometry and topology to cosmological datasets.)
- 2006 – 2009 • MS in Physics, Dept. of Physics, Indian Institute of Science, Bangalore, India.

- 2003 – 2006 • B.Sc. in Physics (Honours) and Mathematics, St. Stephens college, University of Delhi, India

Grants, fellowships and awards

- 2019 – 2021 FIL Interlab grant, in collaboration with INSA Lyon.
 2017 – 2022 ERC advanced grant fellowship, ENS de Lyon, Lyon, France
 2016 – 2017 Andrew and Erna Viterbi Fellowship, Technion, Israel
 2015 – 2017 ERC advanced grant fellowship, Technion, Haifa, Israel
 2010 – 2014 Ubbo Emmius Fellowship (PHD), University of Groningen, Groningen, The Netherlands
 2007 – 2008 Selected for undergraduate research school, University of Lancashire, UK
 2006 – 2007 Selected for undergraduate research school, National University of Singapore, Singapore
 2003 – 2006 Council of Scientific and Industrial Research (CSIR) student associate under Central Program for Youth Leadership in Science (CPYLS) for being in the top 0.1 % scorers in higher secondary examination at national level, India
 2002 School topper's gold medal for scoring highest mark in the school in higher secondary examination, India
 2002 National Cyber Olympiad, All India Rank 5
 2001 National Cyber Olympiad, All India Rank 1

Teaching

- 2012-2014 Teaching Assistant, University of Groningen. Taught tutorial sessions and performed assessment in undergraduate courses in astrophysics and applied topology.
 2007-2009 Laboratory and course assistance, Indian Institute of Science. Assisted in introductory level course in physics.
 2003-2006 Taught physics at high school level during bachelor course.

Student Supervision

- 2021 Alina Mikhaylenko, Department of Mechanics and Mathematics, Novosibirsk State University, Novosibirsk, Russia, *Co-supervisor with Prof. Nikita S. Kalinin, St. Petersburg State University.*
 2020-2021 Siddharth Kumar, Department of Physics, IISc, Bangalore *Co-supervisor with Malcolm Egan, INSA Lyon, MS project, under FIL Interlab grant.*
 2017-2021 Quentin Vigneron, ENS de Lyon, *Co-supervisor with Prof. Thomas Buchert, PhD Candidate.*
 2021-2022 Aubin Courty, ENS de Lyon, *Co-supervisor with Prof. Thomas Buchert, PhD Candidate.*
 2012-2014 Keimpe Nevenzeel, Kapteyn Astronomical Institute, *Co-supervisor with Prof. Rien van de Weygaert, MS Candidate.*
 2012-2014 Matti van Engelen, Kapteyn Astronomical Institute, *Co-supervisor with Prof. Rien van de Weygaert, BSc Candidate.*

Service

Review:

- Invited book review, *Computational topology for Biomedical Images and Data: Theory and Applications*, IEEE Signal Processing Magazine 38 (4), 130-131, 2021.
- Review services for *Astronomy & Astrophysics (A & A)*, *Journal of Cosmology and Astroparticle Physics (JCAP)*, and *Monthly Notices of the Royal Astronomical Society (MNRAS)*.

Workshop and Seminar Organization:

- *Two round table conferences at ENS de Lyon, funded from ERC grant, 2017, 2019 with Thomas Buchert.*

Outreach:

- 2020 • Producing a movie for school students in Russia about interaction of applied mathematics and cosmology.
- 2015-2017 • Organized telescope viewing events in association with amateur astronomers and Technion for general public.
- 2011-2013 • Assisted in public outreach events conducted by Kapteyn Astronomical Institute during PhD. Gave lectures and telescope demonstration to a general audience of non-scientists including school students.
- 1998- • Constant engagement with the Ramakrishna Mission (RKM) organization in voluntary educational activities aiming at providing education to rural, underprivileged children at all levels of school in India, including teaching time during trips to India.

Publications

Citations: 661 (Google Scholar)

***h*-index:** 12 (Google Scholar)

***i*10-index:** 13 (Google Scholar)

Published:

F. Telschow, D. Cheng, **P. Pranav**, and A. Schwartzman, *Estimation of expected Euler characteristic curves of non-stationary smooth Gaussian random fields*, accepted for publication in *Annals of Statistics*, 2023.

Pavan Kumar Aluri, Paolo Cea, Pravabati Chingangbam, Ming-Chung Chu, Roger G. Clowes, Damien Hutsemékers, Joby P. Kochappan, Andrzej Krasinski, Alexia M. Lopez, Lang Liu, Niels C. M. Martens, C. J. A. P. Martins, Konstantinos Migkas, Eoin Ó Colgáin, **Pratyush Pranav**, Lior Shamir, Ashok K. Singal, M. M. Sheikh-Jabbari, Jenny Wagner, Shao-Jiang Wang, David L. Wiltshire, Shek Yeung, Lu Yin, Wen Zhao, *Is the Observable Universe Consistent with the Cosmological Principle?*, *Classical and Quantum Gravity*, 40 (9), 094001, 2023.

P. Pranav, *Anomalies in the topology of the temperature fluctuations in the cosmic microwave background: An analysis of the NPIPE and FFP10 datasets*, *Astronomy & Astrophysics*, 659, A119, 2022.

S Appleby, C Park, **P. Pranav**, SE Hong, HS Hwang, J Kim, T Buchert, *Minkowski Functionals of SDSS-III BOSS: Hints of Possible Anisotropy in the Density Field?*, *The Astrophysical Journal*, 928 (2), 108, 2022.

G. Wilding, K. Nevenzeel, R. van de Weygaert, G. Vegter, **P. Pranav**, B. J. T. Jones, K. Efstathiou, J. Feldbrugge, *Persistent homology of the cosmic web. I: Hierarchical topology in Λ CDM cosmologies*, *Monthly Notices of the Royal Astronomical Society*, 507 (2), 2968-2990, 2021.

P. Pranav, R. J. Adler, T. Buchert, H. Edelsbrunner, B. J. T. Jones, A. Schwartzman, H. Wagner, and R. Van de Weygaert, *Unexpected topology of the temperature fluctuations in the cosmic microwave background*, *Astronomy & Astrophysics*, 627, A163, 2019.

P. Pranav, R. Van de Weygaert, G. Vegter, B. J. T. Jones, R. J. Adler, J. Feldbrugge, C. Park, T. Buchert, and M. Kerber, *Topology and geometry of Gaussian random fields I: On Betti numbers, Euler characteristic and Minkowski Functionals*, *Monthly Notices of the Royal Astronomical Society*, 485(3), 4167-4208, 2019.

J. Feldbrugge, M. van Engelen, R. van de Weygaert, **P. Pranav**, G. Vegter, *Stochastic ho-*

mology of Gaussian vs. non-Gaussian random fields: graphs towards Betti numbers and persistence diagrams, Journal of Cosmology and Astroparticle Physics, 2019 (9), 052, 2019.

R. J. Adler, S. Agami, and **P. Pranav**, *Modelling and replicating statistical topology, and evidence for CMB non-homogeneity*, Proceedings of the National Academy of Sciences, 114 (45), 11878-11883, 2017.

P. Pranav, H. Edelsbrunner, R. Van de Weygaert, G. Vegter, M. Kerber, B. J. T. Jones, M. Wintraecken, *The topology of the cosmic web in terms of persistent Betti numbers*, Monthly Notices of the Royal Astronomical Society, 465(4), 4281-4310, 2016.

N. Shivshankar, **P. Pranav**, V. Natarajan, R. van de Weygaert, E. G. P. Bos, S. Reider, *Felix: A topology based framework for visual exploration of cosmic filaments*, IEEE Transactions on Visualizations and Computer Graphics, 22 (6), 1745-1759, 2015.

P. Pranav, *Persistent Holes in the Universe: A (hierarchical) Topology of the Cosmic Mass Distribution*, PhD Thesis, University of Groningen, 2015.

C. Park, **P. Pranav**, P. Chingangbam, R. van de Weygaert, B. J. T. Jones, G. Vegter, I. Kim, J. Hidding, W. Hellwing, *Betti numbers of Gaussian random fields*, Journal of the Korean Astronomical Society, 46, 125-131, 2013.

R. van de Weygaert, G. Vegter, H. Edelsbrunner, B. J. T. Jones, **P. Pranav**, C. Park, W. Hellwing et. al., *Alpha, Betti and the megaparsec universe: on the topology of the cosmic web*, Transactions on Computational Science, 14, 60 – 101, Springer Verlag, 2011.

P. Pranav, C. J. Jog, *Response of a galactic disk to vertical perturbations: strong dependence on density distribution*, Monthly Notices of the Royal Astronomical Society, 406 (1), 576-585, 2010.

INVITED BOOK REVIEW:

P. Pranav, *Computational topology for Biomedical Images and Data: theory and applications* [[Book Review]], IEEE Signal Processing Magazine, 38 (4), 130-131, 2021.

UNDER REVIEW, PREPRINTS:

P. Pranav, *Topology and geometry of Gaussian random fields II: on critical points, excursion sets and persistent homology*, [arXiv:2109.08721](https://arxiv.org/abs/2109.08721).

P. Pranav, and Thomas Buchert, *Homology reveals significant anisotropy in the cosmic microwave background*, [arXiv:2308.10738](https://arxiv.org/abs/2308.10738).

Conferences and colloquia

“Challenges to LCDM” conference, Thessaloniki, Greece, 2022.

“Topological signatures of CMB anomalies”, Colloquium, Kavli IPMU, Tokyo, Japan, 2022.

“Anomalies in the topology of the fluctuations in the Cosmic Microwave Background”, Colloquium, University of Geneva, Geneva, Switzerland, 2021.

“Topo-geometrical methodologies in cosmology: Theory and applications”, International Online Conference Algebraic and Geometric Methods of Analysis – online, Odessa, Ukraine, 2021

“Topological characteristics of temperature fluctuations in the Cosmic Microwave Background”, Theory of Gravitation and Variation in Cosmology (2nd Edition) – online, Centre International de Rencontres Mathématiques (CIRM), Luminy, France, 2021

“Topology and geometry of cosmological datasets: theory and applications”, colloquium, Institut Ruder Boskovic, Zagreb, Croatia, 2021

“Topology and geometry: Application to cosmological datasets”, Korean Institute of Advanced Studies 9th Cosmology workshop – online, Seoul, South Korea, 2020

“Topology of fractal models: an approach to characterizing cracks in reservoirs”, 48th International -Summer School-Conference – online, Advanced Problems in Mechanics, Moscow, Russia, 2020

“Unexpected topology of the temperature fluctuations in the Cosmic Microwave Background”, CAFFE LATTES: cosmological analysis featuring galactic foreground emission, Lattes, France, 2020

“Topology of the matter distribution in the Universe”, Colloquium, Chebyshev Lab. of Applied Mathematics, St. Petersburg State University Russia, 2019

“Simplicial Topology”, Colloquium, Discrete and Computational Geometry Lab., Jaroslavl State University Russia, 2019

“Testing isotropy and homogeneity in the CMB”, Inhomogeneous cosmologies IV, Torun, Poland, 2019

“Persistent holes in the Universe”, Colloquium, Indian Institute of Astrophysics, Bangalore, India, 2019

“Hierarchical topology of the cosmic mass distribution”, Colloquium, Indian Institute of Science, Bangalore, India, 2019

“Hierarchical topology of the cosmic mass distribution”, Colloquium, Indian University Center for Astronomy and Astrophysics, Pune, India, 2019

”Hypothesis testing with persistent homology”, Colloquium, Institut national des sciences appliques de Lyon (INSA LYON), 2019

“Identification of cosmic structures”, Colloquium, Ludwig-Maxmillian University (LMU), Munich, Germany, 2018

“Tukey depth and CMB data”, Session at CME Statistics conference, Pisa Italy, 2018

“Relative homology for masked datasets: Application to CMB”, Seminar at Institute of Science and Technology (IST), Vienna, Austria, 2017

“Inhomogeneity in the CMB: analysis of Planck maps”, Inhomogeneous cosmologies IV, Torun, Poland, 2019

“MS complex segmentation and identification of cosmic structures”, Applied Topology: Methods, Computation and Science (ATMCS), Turin, Italy, 2016

“Intensity maps as empirical probabilistic description of persistence diagrams”, Applied Probability seminar, Department of Mathematics, Technion, Israel, 2014

“Topological data analysis”, Institute of Mathematics and its Applications, University of Minnesota, Minneapolis, 2013

“Alpha, Betti and the megaparsec Universe”, Tea talk, Kavli Institute of Particle Astrophysics and Cosmology, Stanford University, 2013

“Alpha shape topology of the cosmic mass distribution”, Lunch talk at Johns Hopkins University, Baltimore, USA, 2013

“Topology of level sets of cosmological simulations”, Lunch talk at Caltech, Pasadena, USA, 2013

“Probing dark energy with alpha shapes and Betti numbers”, Geometry and topology of cosmic web, Warsaw, Poland, 2012

“Probing for primordial non-Gaussianity using topological methods”, Primordial Features and Non-Gaussianities, HRI, Allahabad, India, 2010

“Persistent topology of the LCDM universe”, Topological data analysis, Monastir, Tunisia, 2010

“Algebraic topology and cosmic structure formation”, Workshop on topology and cosmology, Leiden, Netherlands, 2009

Research Visits

2018 –

- Department of Physics, Geneva University, Switzerland. Host: Prof. Ruth Durrer. Period: 3 days.
- Department of Electrical Engineering, Technion, Israel. Host: Prof. Robert Adler. Period: 6 weeks.
- Chebyshev Lab. for applied maths, St. Petersburg, Russia. Host: Prof. Iskander Taimanov. Period: 1 week.
- Department of Computer Science, Jaroslavl State University, . Host: Prof. Iskander Taimanov. Period: 1 week.
- LMU, Munich, UK. Host: Prof. Jochen Weller. Period: 1 week.
- Institute of Science and Technology, Austria. Host: Prof. Herbert Edelsbrunner. Period: 4 weeks.
- Indian Institute of Astrophysics, India. Host: Prof. Pravabati Chingangbam. Period: 2 weeks.
- Institute of Mathematical Sciences, Chennai, India. Host: Prof. Areejit Samal. Period 1 week.

2015 – 2018

- Kapteyn Astronomical Institute, the Netherlands. Host: Prof. Rien van de Weygaert. Period: 4 weeks.
- Institute of Science and Technology, Austria. Host: Prof. Herbert Edelsbrunner. Period: 4 weeks.
- Indian Institute of Astrophysics, India. Host: Prof. Pravabati Chingangbam. Period: 2 weeks.

2011 – 2015

- Every year a month or two to Edelsbrunner group, IST Austria
- INRIA Saclay, Host: Frederic Chazal. Period: 1 month
- INRIA Sophia-Antipolis, Antibes, France, Host Monique Teillaud. Period: 1 month.
- Inter University Center for Astronomy and Astrophysics, India, Host: Varun Sahni. Period: 1 month.